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ANNUAL REPORT

OF

*Chas. D. Walcott*

THE UNITED STATES

GEOLOGICAL AND GEOGRAPHICAL SURVEY

OF

THE TERRITORIES/

EMBRACING COLORADO,

BEING A REPORT OF PROGRESS OF

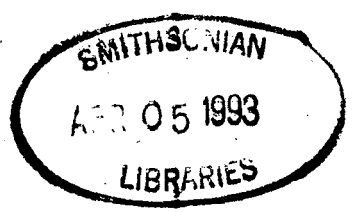
THE EXPLORATION FOR THE YEAR 1873,

BY

F. V. HAYDEN,  
UNITED STATES GEOLOGIST.

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# REPORT ON THE VERTEBRATE PALEONTOLOGY OF COLORADO.

BY EDWARD D. COPE, A. M.

PHILADELPHIA, *July 12, 1874.*

SIR: I send herewith a report on the stratigraphical relations and vertebrate paleontology of the formations which represent the Cretaceous, Eocene, Miocene, and Pliocene periods in Colorado, with a few species from other localities added. This essay is based on material collected by myself during a part of the summer and autumn of the year 1873, under the auspices of the geological survey of which you are director. This represents the following numbers of species from the respective formations, to which I have added the number from each which is believed to have been first introduced to the knowledge of paleontologists:

Formation.	Total.	New.
Pliocene .....	21	9
Miocene.....	75	59
Eocene.....	15	7
Cretaceous .....	38	19
Total .....	149	94

I hope that the report will subserve the objects of the survey, I remain, with respect,

EDWARD D. COPE,  
*Paleontologist.*

Dr. F. V. HAYDEN,  
*Geologist in Charge, &c*

## CHAPTER I.

### INTRODUCTION.

The water-shed between the South Platte River and Lodge Pole Creek is composed superficially of formations of the Pliocene epoch as defined by Hayden. The latter stream flows eastwardly through the southern parts of Wyoming and Nebraska, and empties into the South Platte near Julesburgh, Nebr. The territorial and state boundaries traverse this water-shed from west to east. The springs on its southern slope, which form the sources of the northern tributaries of the South Platte, issue from beneath the beds of the formation above named. At or near this point is an abrupt descent in the level of the country, which generally presents the character of a line of bluffs varying from two to nine hundred feet in height. This line forms the eastern border of the valley of Crow Creek until it bends to the eastward, when it extends in a nearly east and west direction for at least sixty miles.\* At various points along it, portions have become isolated through the action of erosion, forming "buttes." Two of these, at the head of Middle Pawnee Creek, are especially conspicuous landmarks, forming truncate cones of about 900 feet in elevation, as Mr. Stevenson, of the survey, informs me. They are called the Pawnee or sometimes the White Buttes; near them stand two others, the Castle and Court-House Buttes.

The upper portion of this line of bluffs and buttes is composed of the Pliocene sandstone in alternating strata of harder and softer consistence. It is usually of medium hardness, and such beds, where exposed on both the Lodge Pole and South Platte slopes of the water-shed, appear to be penetrated by innumerable tortuous, friable, siliceous rods and stem-like bodies. They resemble the roots of the vegetation of a swamp, and such they may have been, as the stratum is frequently filled with remains of animals which have been buried while it was in a soft state. No better-preserved remains of plants were seen. The depth of the entire formation is not more than 75 feet, of which the softer beds are the lower, and vary in depth from 1 foot to 20. The superior strata are either sandstone conglomerate or a coarse sand, of varying thickness and alternating relations; the conglomerate contains white pebbles and rolled Pliocene mammalian remains.

This formation rests on a stratum of white, friable, argillaceous rock of Miocene age, probably of the White River epoch, as I believe, from the presence of the following species, which I detect in it: *Hyaenodon horridus*, *H. crucians*, *Oreodon culbertsonii*, *O. gracilis*, *Pœbrotherium wilsonii*, *Aceratherium occidentale*, *Hyracodon nebrascensis*, *Anchitherium bairdii*, *Palæolagus haydenii*, *Ischromys typus*, *Mus elegans*, &c. The formation extends to a depth of several hundred feet, and rests on a stratum of a fine-grained, hard, argillaceous rock of a dark-brown color. Some of its strata are carbonaceous, and contain vegetable remains badly preserved; others are filled with immense numbers of fresh and brackish water shells, including oysters. I do not know the depth of this bed, but followed it to the southward until it disappeared beneath the Loess of the South Platte. The age of this formation is identical with that which underlies the fresh-water basins of Dakota and Wyoming according to Hayden, and concerning which difference of opinion

\* See Berthoud, *Proceed. Acad. Nat. Sci. Phila.*, 1872, p. 48, where the bluffs are mentioned.

exists among geologists. I, however, succeeded in procuring a number of fossil vertebrates from it, which not only prove conclusively its Mesozoic age, but its horizontal identity with the reptile-bearing Fort Union beds of the Upper Missouri. This formation, which has been usually regarded as Tertiary, I determined to be Cretaceous in 1869, and the present discoveries establish that view as correct. The fossils which are described in the following pages represent *Dinosauria* of three species, a crocodile, and several tortoises, identical specifically with those obtained by Dr. Hayden on the Missouri, Big Horn Rivers, &c. Some of the shells I submitted to Mr. Conrad, and he pronounces them to be *Cyrenas*.

South of the South Fork of the Platte, the Cretaceous beds have an extensive development, and south of the Kansas Pacific Railroad contain some beds of pretty good coal. The high tract of land which extends east from the Rocky Mountains, and constitutes the "divide" between the waters of the Platte and Arkansas, is composed of Tertiary strata lying nearly horizontal. A few days' exploration among them revealed chiefly hard, coarse sandstones and conglomerates, which belong to the Monument Creek group of Hayden. The more elevated hills nearest the mountains are capped by a light-colored trachytic rock, believed to be of volcanic origin. While it overlies the Monument Creek formation, the sandstone of the latter not infrequently incloses angular fragments of a similar rock, showing that the outflow commenced prior to the period of its deposit, and continued subsequently. The age of the Monument Creek formation in relation to the other Tertiaries not having been definitely determined, I sought for vertebrate fossils. The most characteristic one which I procured was the hind leg and foot of an *Artiodactyle* of the *Oreodon* type, which indicated conclusively that the formation is newer than the Eocene. - From the same neighborhood and stratum, as I have every reason for believing, the fragment of the *Megaceratops coloradoensis* was obtained. This fossil is equally conclusive against the Pliocene age of the formation, so that it may be referred to the Miocene until further discoveries enable us to be more exact.

Fresh-water strata of probable Eocene age were, however, detected by both Dr. Hayden's party and my own in the South Park. These consist of laminated argillaceous shales of soft consistency, in which great numbers of fishes and plant impressions are preserved. The fishes are referable to only two species, *Amyzon commune* and *Rhineastes pectinatus*, and are described in chapter II. They are nearly related to species of the Elko shales and Bridger formation, and I suspect that their age is Eocene.

From Trout Creek, near Fairplay, we procured a number of invertebrate fossils of Lower Cretaceous age, a few of which are described by Mr. Conrad in chapter II.

Thus it appears that, in Colorado as in Dakota, the formations of the Loup Fork, White River, and Fort Union epochs are present, and display a similar succession of life, and that the corresponding horizons display identity in the generic and often specific forms of life. They also exhibit the same marked faunal distinctness from each other in Colorado as in Dakota, and the Colorado fauna displays the same strong diversity from the Eocene fauna of Wyoming in respect to the genera, families, and orders which can be compared.

pectoral spine is rather small, and bears a row of recurved hooks on its posterior face; there are none on the anterior face.

The head is broad, short, and rounded in front, which, with the uncinate character of the serration of the pectoral spine, reminds one of the existing genus *Noturus*. As compared with the five species of *Rhineastes* described from the Bridger Eocene, the present species is distinguished by the small size and uncini of the pectoral spine.

#### Measurements.

	M.
Length of head to clavicle, (below).....	0.018
Width of head, (below).....	.036
Width of scapular arch, (below).....	.011
Expanse modified diapophyses.....	.020
Length of modified vertebrae.....	.0115
Length of pectoral spine.....	.01

From the Tertiary shale of the South Park, Colorado.

#### AMYZON, Cope.

Hayden's Annual Report, 1872, p. 642.

AMYZON COMMUNE, Cope, *Bullet. U. S. Geol. Survey*, No. 2, 1874, p. 50.

In describing this species, the following additions to our knowledge of the generic characters may be made. There is an open fronto-parietal fontanelle; the premaxillary forms the entire superior arch of the mouth; the pharyngeal bones are expanded behind; there are 12-13 rays of the ventral fin; there is a lateral line of pores, which divides the scales it pierces to the margin.

The greatest depth of the body is just anterior to the dorsal fin, and enters the length 2.66 times to the base of the caudal fin, or a little more than three times, including the caudal fin. The length of the head enters the former distance a little over 3.25 times. The general form is thus stout and the head short; the front is gently convex and the mouth terminal. There are fifteen or sixteen rows of scales between the bases of the dorsal and ventral fins. They are marked by close concentric lines, which are interrupted by the radii, of which eight to fifteen cross them on the exposed surface, forming an elegant pattern. At the center of the scale, the interrupted lines inclose an areolation. The extended pectoral fin reaches the ventral, or nearly so; the latter originates beneath the anterior rays of the dorsal, or in some specimens a little behind that point. They do not reach the anal when appressed. The anal is rather short and has long anterior radii. The dorsal is elevated in front; the first ray is a little nearer the basis of the caudal fin than the end of the muzzle. Its median and posterior rays are much shortened; the latter are continued to near the base of the anal fin. Radii, D., 33; P., 14; V., 13; A., 12. The caudal is strongly emarginate, and displays equal lobes.

#### Measurements.

	M.
Length of a large specimen, (10.25 inches).....	0.250
Length of a medium specimen.....	.182
Depth at occiput.....	.043
Depth at dorsal fin.....	.057
Depth at caudal peduncle.....	.023
Length of head, axial.....	.044
Length to D. 1, axial.....	.075
Length to end of dorsal, axial.....	.131
Length to basis of caudal fin.....	.146
Length of basis of anal fin.....	.023

There are thirty-eight or thirty-nine vertebræ, of which nine are anterior to the first interneural spine, and fourteen between that point and the first caudal vertebra.

A very large number of specimens was obtained by Dr. Hayden and myself from the Tertiary shales of the Middle and South Parks, Colorado. They display but insignificant variations in all respects, and furnish a good basis of determination. They all differ from the *A. mentale*, Cope, (Proceed. Amer. Philos. Soc., 1872, p. 481,) in the larger numbers of vertebræ and dorsal and anal fin radii, and greater prolongation of the dorsal fin. It is, however, nearly allied to the species of the Osino shales. The only fish found associated with this one is the small nematognath just described. The predominance of these types and exclusion of the brackish-water genera *Asineops*, *Erismatopterus*, and *Clupea*, so abundant in the shales of the Green River epoch, indicate a more lacustrine, and hence, perhaps, though not necessarily, later deposit.

### CLUPEA, Linn.

CLUPEA THETA, Cope, Bullet. U. S. Geol. Surv., No. 2, 1874, p. 51.

Represented by a specimen from the Green River shales, near the mouth of Labarge Creek, in the upper valley of Green River. It is a larger species than the *C. pusilla*, Leidy, which is also found at the same locality, and has a much longer anal fin. Its radii number twenty-six, possibly a few more, as the end appears to have been injured. The dorsal fin is short; the last ray in advance of the line of the first of the anal. The body is deep. Number of vertebræ from the first interneural spine to the last interhæmal, twenty-nine. Depth at first dorsal ray, 0.0485; depth at last anal ray, 0.0170; length of twenty-nine vertebræ, 0.0780.

## CHAPTER IV.

### THE MIOCENE PERIOD.

The fauna of the White River epoch is well known to be entirely distinct from that which preceded it, which is preserved in the beds of the Bridger formation; no species or genus of mammal is common to the two, and but a proportion of the families. This difference is similar to that which distinguishes the Lower Eocene from the Miocene fauna of Europe. The parallelism of the Wyoming fauna with that of the Eocene of France and Switzerland is very full, although not without exceptions. Both are characterized by the absence of equine perissodactyles and ruminant artiodactyles, of *Elephantidæ*, *Rhinocerotidæ*, and extreme poverty in feline and musteline, or the higher carnivora. Both are characterized by the presence of lemurs and generalized quadrumana, and by the great predominance of *Perissodactyla* allied to the tapirs. Parallel genera of the respective groups may be thus exhibited:

#### WYOMING.

Carnivora,  
Quadrumana,  
Perissodactyla,

Artiodactyla,

*Mesonyx.*  
*Anaptomorphus.*  
*Palæosyops.*  
*Hyrachyus.*  
*Hyopsodus.*  
*Achænodon.*

#### FRANCE.

*Hyænodon.*  
*Adapis.*  
*Palæotherium.*  
*Lophiodon.*  
*Hyacotherium.*  
*Anthracotheium.*